REMARKS

Further to the Office Action mailed March 13, 2009, Applicant respectfully requests reconsideration.

Allowable Subject Matter

The Examiner has indicated that claims 10, 12 and 19 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

By this amendment, Applicant has added new claim 21 that incorporates the subject matter of allowable claim 10, its intermediate claim 9 and base claim 1. Applicant respectfully submits that new claim 21 is, therefore, allowable.

Obviousness Rejections Under 35 USC §103

Claims 1-4, 6-9, 11, 13, 15-18 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over US Patent 6,001,419 to Leluan in view of US Patent 6,210,745 to Gaughan and further in view of "Formation of Pyrolytic Carbon During the Pyrolysis of Ethane at High Conversions," by Glasier. Applicant respectfully traverses.

Generally, embodiments of the present invention provide for densifying a porous substrate with pyrolytic carbon. The process is controlled in real time so as to optimize infiltration parameters in order to reduce the total time necessary to complete the process of densification. The process takes account of the real conditions under which the chemical vapor infiltration process is taking place by monitoring selected compounds in the effluent gas and adjusting selected operating parameters accordingly.

Applicant submits that the Examiner has failed to establish a *prima facie* case of obviousness as there has been no articulated explanation provided for combining Leluan, directed to a densification process, and Gaughan and Glasier, each directed to a surface coating process. The technical problems being addressed in the densification process, as per the present application, are sufficiently different from those problems being addressed in the surface coating process that Applicant submits that one of ordinary skill in

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densification technology would not look to surface coating technology for a solution and vice versa.

As reiterated by the Supreme Court in *KSR International Co. v. Teleflex Inc. (KSR), 550 U.S. ___, 82 USPQ2d 1385 (2007),* the framework for the objective analysis for determining obviousness is stated in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). Obviousness is a question of law based on these underlying factual inquiries: (A) determining the scope and content of the prior art; (B) ascertaining the differences between the claimed invention and the prior art; and (C) resolving the level of ordinary skill in the pertinent art. (See MPEP § 2141) Once the *Graham* factual inquiries are resolved, the obviousness analysis must be made.

Leluan is directed to a method of chemical vapor infiltration with variable infiltration parameters for accomplishing a densification process. (Abstract). Leluan discloses that it is necessary to adapt the infiltration parameters throughout the densification process as a function of changes in the porometry, i.e., the size and shape of the internal pores of the substrate, as the pores are being filled. (Col. 4, lines 27-28). The variation of parameters, for example, temperature, pressure, gas flow rate, or gas retention (or transit time), is controlled in a predetermined manner and not as a function of a content in the affluent gas, i.e., in "real-time," as in the present application.

The Examiner acknowledges that Leluan "fails to disclose controlling the process by measuring the contents in the effluent gas." (Office Action, page 3). According to the Examiner, however, "Gaughan discloses controlling a vapor deposition process by using a residual gas analyzer" to "improve real time monitoring of the process" and that it would have been obvious to modify Leluan to "analyze the effluent gas to control the process" as, according to the Examiner, "taught by Gaughan." (Ibid.)

Gaughan is directed to a surface coating process in which the chemical vapor in the chamber is monitored. (Col. 2, lines 10-13). According to Gaughan, there is a correlation between the amounts and ratios of various gases in a deposition chamber and the amount of material that has been deposited. (Col. 3, line 25 - col. 4, line 8). Gaughan teaches that a residual gas analyzer (RGA) can be used as a quality control system to monitor the surface coating process. (Col. 4, lines 8-47). Specifically, predetermined parameters are

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implemented to deposit a film and a resulting gaseous environment is measured. (Col. 6, lines 8-13; Fig. 3, steps 76, 78). The gaseous environment is measured and compared to an expected value range based on the amount of material that was meant to be deposited. (Col. 6, lines 14-20; Fig. 3, steps 80, 82). If the measured gases fall within the range, then the amount of deposited material is acceptable. If, however, the measured gases are out of range, then the amount of material that has been deposited is not acceptable and, therefore the process is outside of specifications.

Applicant notes that Gaughan, as above, is related to a surface coating process, and more particularly to forming a TiN film onto a surface. Gaughan, however, does not relate to a pyrolytic carbon densification process as does Leluan and the present application. As set forth in the present specification, to successfully complete the process of densification of at least one porous substrate with pyrolytic carbon by chemical vapor infiltration, the reaction gas has to reach the internal porosity of the substrate before forming the pyrolytic carbon deposit. As also explained in the present specification, the infiltration process is greatly influenced by the progressive densification of the porous substrate, i.e., the progressive filling of the pores of the substrate.

As Gaughan is related to an external surface coating process, Gaughan does not deal with the problems of filling up the pores of a porous substrate due to changes in porometry, as dealt with by Leluan, as such a problem is necessarily absent, and not an issue, in a surface coating process.

The Examiner submits that Glasier discloses formation of pyrolytic carbon using ethane and discloses that the amount of benzene in the effluent gas relates to the carbon deposition and that it would have been obvious to control deposition by measuring the benzene in the effluent gas.

Glasier also relates to a surface coating process and to the study of the deposition of a pyrolytic carbon coating on quartz, i.e., a non-porous substrate, using ethane as a precursor. (Page 16, Right Col., last paragraph). According to Glasier, there is a correlation between the rate of pyrolytic carbon formation and the benzene concentration in a reactor. According to Applicant's review, however, the only teaching of Glasier with

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respect to benzene is that, in a surface coating process, the higher the benzene concentration in the reactor, the higher the deposition rate.

Similar to Gaughan, Glasier is related to a surface coating process and thus is not addressing the same problem solved by the present invention. Further, there is no teaching in Glasier that the regulation of the benzene concentration could assist in keeping a pyrolytic carbon microstructure unchanged. In Glasier the only mention of the pyrolytic carbon microstructure is a reference to prior studies having allegedly shown a correlation between pyrolytic carbon microstructure and a ratio of acetylene/benzene in a "hydrocarbon product." (Page 15, middle of the right column). In other words, with respect to pyrolytic carbon microstructures, there is, at most, a vague indication in Glasier that it is the ratio of the acetylene to benzene which is important but not, however, that it is the benzene concentration itself that is relevant.

Applicant respectfully submits that, absent a reference to Applicant's own teaching, no motivation to combine Leluan, Gaughan and Glasier, has been offered by the Examiner. As Leluan is in a different technical art from that of Gaughan and Glasier, the absence of a stated motivation to combine is fatal to the obviousness rejection.

In light of the failure of the Examiner to present a *prima facie* case of obviousness, Applicant respectfully submits that claim 1 is allowable. Further, as claims 2-4, 6-9, 11, 13, 15-18 and 20 depend, either directly or indirectly, from allowable claim 1, Applicant respectfully submits that these claims are also allowable.

Assuming, without agreeing, that the cited combination of references is appropriate, Applicant respectfully submits that the combination results in a system that monitors a gaseous environment in order to determine if an already completed process has deposited material according to specification but, in contrast to the present invention, however, does not adjust parameters of the process as a function of the measured gas.

As above, Leluan uses predetermined settings for a densification process and Glasier discloses a vague teaching as to a relationship between acetylene and benzene and a rate of formation. Gaughan discloses that the gaseous environment can be

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measured to determine how much material was deposited only after the deposition process has been completed.

> ...if the resulting gaseous environment is outside the range, then the actual physical property is outside tolerable levels of the designated physical property. In such a case, the process indicates that the wafer is outside of specification. (Gaughan, Col. 6, lines 23-27, emphasis added).

To reiterate, the cited combination results in a measure of how much material has been deposited by sampling the gaseous environment.

In contrast, claim 1 recites a densification method characterized by measuring at least one selected compound in the effluent gas and controlling the process, as a function of the measured content, by adjusting at least one selected parameter.

The cited combination does not control the process but, rather, only monitors the process.

For at least the foregoing reason, Applicant respectfully submits that claim 1, and its dependent claims, are not obvious over the cited combination of references.

Claims 5 and 14 stand rejected as being unpatentable over Leluan in view of Gaughan and Glasier and further in view of "A Reduced Reaction Model for Carbon CVD/CVI Processes" by Birakayala. Applicant respectfully traverses.

Applicant submits that Birakayala does not remedy the deficiencies of Leluan, Gaughan and Glasier with respect to independent claim 1 from which claims 5 and 14 depend.

The Birakayala reference is related to the making of Carbon-carbon composites by densification of a porous carbon fibrous substrate. (Page 675, Introduction, first sentence). The densification is achieved by deposition of carbon within the pores of the substrate as is well known. (Ibid). An object of Birakayala is to provide a model for an infiltration process that predicts the changes in pore geometry with respect to time. (Abstract, pages 675-676, model development, bottom of left column).

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The Examiner maintains that Leluan in view of Gaughan and Glazier discloses controlling the process by adjusting the flow rate of the gases in response to effluent gas concentrations but fails to disclose measuring the amount of allene and/or propine content. The Examiner further maintains that Birakayala discloses allene and/or propine are known reaction products during the formation of carbon during an infiltration process and therefore "taking the references collectively," it would have been obvious to modify Leluan in view of Gaughan and Glasier to adjust the process parameters in response to the allene and/or propine concentration "because Birakayala discloses such is present in measurable quantities in the affluent gas of a CVI carbon densification process." (Office Action, page 5, paragraph 4).

Birakayala provides a detailed discussion about gas phase kinetics, surface kinetics and pore closure models that can be used to predict deposition profiles within the pores. With respect to the gas phase kinetics, Birakalaya mentions that the complete mechanism is made up of 47 reversible reactions with 19 species. (Page 676, right column, section gas phase kinetics, first paragraph, lines 14-15). There is a reference to C_3H_4 in Table 1 and Fig. 2 but Applicant can find no indication or suggestion that the densification process could be controlled as a function of the C_3H_4 content in the affluent gas.

As above, Gaughan and Glasier are directed to forming a coating on the surface of a substrate. In a densification process, in contrast to a surface coating process, the changes in porometry, namely the progressive closure of the pores of the substrate greatly influences the process, as discussed above. This is reiterated in Birakayala because the pore closure model is one of the three components of the overall process model.

Similar to the arguments submitted above, a pore closure model, as described by Birakayala, is completely irrelevant to an external surface coating process such as described by Gaughan and Glasier. One of ordinary skill in the art, when implementing a surface coating process, has no use for the teachings related to the problem of controlling a densification process as described by Birakayala.

Assuming, without agreeing, that the combination of these references is proper, Applicant submits that there is still no teaching or suggestion to be found in this combination of references of adjusting the flow rate of the reaction gas, or the flow rate of

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a component of the reaction gas, as a function of the measured allene and/or propine content, as recited in the claims.

Thus, Applicant respectfully submits that claims 5 and 14 are not rendered obvious by the cited combination of references for at least the reasons that there has been no rationale provided for combining the teachings of a densification process, as represented by Leluan and Birakayala, with those of a surface coating process, as represented by Gaughan and Glasier, and that the cited combination, even if proper, does not teach or suggest all of the limitations of the claims.

In view of the foregoing, Applicant believes the pending claims are in condition for allowance and a notice to this effect is earnestly solicited. The Examiner is encouraged to telephone the undersigned attorney to discuss any matter that would expedite allowance of the present application. The Examiner is hereby authorized to charge any fees due to this submission under 37 C.F.R. §§ 1.16 and 1.17, or credit any balance, to Deposit Account No. 23-0804.

Respectfully submitted,

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